**Alternative** **Assessment** in **Elementary** **School** **Mathematics**

|  |  |
| --- | --- |
|  |  |

|  |  |
| --- | --- |
| AUTHOR: | Thomasenia L. Adams |
| TITLE: | Alternative Assessment in Elementary School Mathematics |
| SOURCE: | Childhood Education 74 no4 220-4 Summ '98 |

    What does it mean to talk about assessing children's mathematics learning, and why is it important? Assessment allows us to collect information about children's understanding of mathematics, as well as their mathematical strengths and weaknesses. It also helps educators identify ways to improve mathematics instruction, curriculum and children's mathematics learning. Assessment is integral to teaching and learning, and it plays a major role in how and what we teach, and in how and what children learn (National Council of Teachers of Mathematics [NCTM], 1989; Pidgeon, 1992).  
    Improving children's mathematics learning also requires that we consider using various assessment techniques (e.g., methods, tasks, assignments, strategies, activities) in the classroom, since "a teacher's assessment practices include all of the ways she/he determines what students know or can do" (Wilson, 1993, p. 4). This quest is often complicated by the nature of understanding, which cannot be measured directly, but must be measured by a variety of inferences (Hiebert & Carpenter, 1992). Therefore, teachers should develop not only appropriate assessment techniques, but also a variety of assessment techniques.  
    Traditionally, educators have relied on paper-and-pencil "problem" tests to assess children's mathematics learning. "Tests are important quantitative assessment tools, but in and of themselves do not constitute the totality of assessment" (Webb, 1992, p. 663). Alternative assessment techniques provide a more comprehensive picture of the learner, and provide more authentic information about the learner, than do traditional assessment techniques, which provide little information about children's understanding and learning. Traditional assessment techniques make it difficult to develop inferences about children's learning, and consequently new ideas about how to improve children's learning are less likely.  
    In this article, the author provides brief, but comprehensive, descriptions of a variety of alternative assessment techniques, and illustrates how to use the techniques to assess children's mathematics learning. The list is not exhaustive, but simply serves as an impetus for developing and implementing alternative assessment techniques.

**IMPLEMENTING ALTERNATIVE ASSESSMENT TECHNIQUES**  
    Any technique that is used to assess children's mathematics learning should reflect the goals and objectives of curriculum and instruction (Thompson & Briars, 1989). A broader perspective to keep in mind "... is that the situation, response, analysis, and interpretation, as well as the mathematical knowledge being assessed, the characteristics of the individual or group who are to respond, and the purpose for assessment must be in alignment" (Webb, 1992, p. 668).

**PORTFOLIOS**  
    Portfolios, a collection of children's work, can be designed to represent many things in relationship to children's mathematics learning experiences. When using portfolios:  
    \* Children should be given the opportunity to provide input regarding the portfolio contents. Children may be allowed to select some or all of the items.  
    \* The type of items selected for the portfolio can be varied, to reflect a real sense of the "whole" child. The items chosen by children will likely provide insight into their interpretation of their work, their dispositions toward mathematics, and their mathematical understanding.  
    \* The portfolio contents are developed over time, allowing teachers to obtain information about children's learning patterns.  
    Portfolio Example: Plane (2-dimensional) Geometry. We can make valid inferences about children's understanding of concepts and skills from examining the work samples they choose for their portfolios. A portfolio used to assess children's learning of plane (2-dimensional) geometry concepts might contain a child's:  
    \* Initial sketches and records of identification of designated plane figures (e.g., square, pentagon) from the time of introduction to the concepts  
    \* Interim sketches and records of identification of the plane figures produced during in-depth learning of the concepts  
    \* Final sketches and records of identification of the plane figures created at the end of instruction on the concepts  
    \* Constructions of models (e.g., paper, geoboards) that represent plane figures  
    \* Written descriptions of plane figures  
    \* Descriptions of how plane figures found in the child's environment are used  
    \* Classifications of plane figures into groups determined by the child  
    \* Records of investigations, explorations and discussions of geometry concepts  
    \* Records of geometry terms and definitions learned and applied  
    \* Items of choice related to the study of plane geometry.

**JOURNALS**  
    Journals are a good tool for assessing children's communication skills. They also provide an avenue for assessing children's reflections of their own capabilities, attitudes and dispositions, and for evaluating their ability to communicate mathematically, through writing.  
    Here are some key ideas for using journals:  
    \* Develop a purpose for journals in the classroom and share this purpose with the children  
    \* Have the children keep a notebook for their journal entries, which will allow them access to previous entries  
    \* Create opportunities for dialogue and add value to the experience for the children by responding to their journal entries  
    \* Allow the children, if they prefer, to share their journal entries with each other  
    \* Encourage the children to review and reflect on their own journal entries to support further monitoring of their learning experiences.  
    Journal Example: Problem Solving. The purpose of a problem-solving journal is to encourage children to view problem solving as more than just an exercise in getting the right answer. Problem solving allows children to develop concepts, skills and strategies for solving new and different problems. Children can be encouraged to review their "track record" to assess their own development in problem solving. Journals can include the following entries:  
    \* Problems they want to solve  
    \* Feelings about being able to solve the problem  
    \* Solution processes  
    \* Discussions of their problem-solving strategies  
    \* Discussions of the validity of the solution  
    \* Alternative solution processes (if appropriate)  
    \* Alternative solutions to the problem (if appropriate)  
    \* Discussions of concepts and skills enhanced by the experience  
    \* Reflections on the problem-solving experience  
    \* Checklists to record such things as learning tools and strategies needed for solving the problem.  
    These entries provide insight on how children are developing as problem solvers, and how teachers might facilitate their development.

**OBSERVATIONS**  
    Observation, an important classroom tool, is used by many teachers, but they may have difficulty collecting and managing assessment information. Here are some ideas for doing so:  
    \* Observe with a specific goal in mind. This keeps the observation data limited and void of extraneous information. Through observations, teachers can assess children's abilities to communicate mathematically, apply mathematics concepts and skills, solve problems and work with others.  
    \* Each child does not need be observed every day. Designate a time for each child to be observed, and focus on that particular child during that time.  
    \* Try not to disturb children when they are working intently. Assume the role of a participant-observer; be part of and live in the learning community, but also be external to the environment when observing.  
    \* Several effective and efficient means for collecting observation information include.  
    \* Carrying notecards and a pen for recording observations  
    \* Developing and using a checklist of desired behaviors and actions  
    \* Using a small, pocket-sized tape recorder for dictating your observations  
    \* Finding areas in the classroom suitable for making observations  
    \* Using a video camera to record your observations  
    \* Sharing observation information, when appropriate, with the children, in order to probe the reasons behind their actions, behaviors and language, and to address their misconceptions about mathematics.  
    Observation Example: Measurement. Common measurement concepts presented in elementary school mathematics instruction are length, width, height, weight, capacity, volume, area, time and temperature. Measurement is a conducive topic for making connections to concrete, hands-on learning activities. Observations, therefore, are particularly well-suited for assessing children's learning of measurement concepts and skills. You may want to observe children's:  
    \* Use of informal and formal measurement terminology (e.g., "long," "short," "big," "large," "small," "little," "wide," "farther")  
    \* Use of arbitrary and standard units (e.g., paper clips, string, inches, centimeters) to make and report measurements  
    \* Discussions of comparisons when exploring measurement concepts (e.g., which containers hold more water [capacity], which ball is heavier [weight])  
    \* Indications that they have developed points of references for measurement (e.g., a cassette tape is about 10 centimeters wide, 37 degrees Celsius is normal human body temperature)  
    \* Appropriate use of measurement concepts and skills to explore their environment.  
    Children learn measurement concepts and skills by measuring. Teachers may make inferences about children's understanding of measurement by observing them as they are engaged in measurement activities.

**SELF-ASSESSMENT**  
    "It is now well-accepted that the ability to assess one's own work is an important element in most forms of learning and that it is an ability which must be cultivated if learners are to engage effectively in lifelong learning" (Doud, 1989, p. 21). To apply this idea of self-assessment, consider the following:  
    \* If children are not accustomed to self-assessment, allow them time to learn how to monitor and assess their own learning  
    \* Children need to be informed about exactly what is meant by assessment, with particular emphasis on the idea that assessment does not necessarily imply grading  
    \* For the purpose of self-assessment, the teacher might provide criteria (e.g., a rubric) to guide the children's self-assessment experiences  
    \* Self-assessment may be subjective (e.g., students examine the clarity of their own written passages, perhaps comparing them to sample passages)  
    \* Self-assessment works better in classrooms where children are not afraid of risk-taking and exposing their errors and misconceptions, and where the outcomes of self-assessment are rewarding (e.g., academically, intrinsically, etc.), rather than in classrooms that place a premium on obtaining the correct answers.  
    Self-Assessment Example: Solid (3-dimensional) Geometry. Children's study of solids (in this case, three-dimensional objects whose surfaces are plane figures) and the models of plane figures used to build solids are valuable components of geometry curricula. One might instruct children to build a solid that can hold an object at a certain height. They can use materials such as straws, toothpicks, pipe cleaners, string, and index cards to model the plane figures. (They may even use the plane figures submitted in the portfolio.) For example, six index cards, used as models of rectangles, can be taped together to build a rectangular prism. Eight straws, used as models of triangles and squares, can be strung together to build a square-based pyramid.  
    After studying solids, children may build a variety of them and then record which concepts and skills they used, and how they solved the problem. When a solid is completed, the children can assess whether or not the solid meets the required condition. Evaluating the strength of the solid for holding objects at a certain height is one example. If the children are successful, they should continue exploring the strength of the solid. If the solid does not meet the criteria, encourage the children to alter their plans and try again. The children will be assessing their application of mathematics concepts and skills, as well as evaluating the outcome of the assignment.

**COMMUNICATION**  
    Classroom communication can take many forms: oral discourse (conversations, discussion, debates), writing (essays, journals), and performance (acting out, modeling). By assessing individual and group communication, we can gather information about children's understanding and application of subject knowledge. Consider the following:  
    \* Children should communicate with, and about, mathematics (NCTM, 1989)  
    \* Various forms of communication should be employed and valued; this is particularly important if any of the children have limited English proficiency  
    \* Children should see themselves not just as respondents to questions, but also as posers of questions  
    \* Children need appropriate levels of receptive and expressive mathematics language skills for participation in further mathematics learning and everyday life experiences.  
    Communication Example: Mathematics As a Language. Mathematical concepts crop up in everyday discourse. We communicate about the weather, sports scores, population growth, investment gains, school grades, medical test results, heart and pulse rates, body temperature, speed of travel, calendar dates, time of day, weight, height, cost of purchases, and on and on. We also can communicate about mathematics through classroom presentations, which require students to use mathematics vocabulary effectively. Remember, however, that students do not benefit from having to memorize mathematical definitions exclusive of understanding and application.  
    Ways to empower students to value mathematics as a language include:  
    \* Instructing students to keep mathematics journals for writing with, and about, mathematics, where they can record their feelings about mathematics, new mathematical ideas and other responses related to mathematics learning  
    \* Placing value on children's uses of informal mathematics language while they develop concepts and skills  
    \* Modeling the use of formal mathematics language  
    \* Designing tasks that require students to examine the uses of mathematics as a language (e.g., designing and breaking codes, working in other number bases, exploring mathematics in other cultures, developing and reading graphs)  
    \* Creating opportunities for all students to share their personal and cultural perspectives on the uses of mathematical language  
    \* Engaging children in classroom presentations of their experiences from mathematical investigations and explorations  
    \* Encouraging children to use multimedia aids for presentations, including cameras, videotape recorders and audiotape recorders.  
    The overriding goal for focusing on communication as a way of obtaining assessment information is to engage children in learning experiences that encourage them to view mathematics as a tool for communicating ideas.

**SURVEYS**  
    The use of surveys is a valid technique for collecting assessment information. Surveys may consist of Likert scale, rating and open-ended items. Keep in mind that:  
    \* Teacher-made and/ or student-made surveys that are given periodically to assess changes in children's affective characteristics can be valuable; teacher-made surveys can be used to assess children's mathematical dispositions, attitudes, efficacy and anxieties  
    \* Surveys also can be used to collect academic, as well as affective, information  
    \* Other forms of classroom communication, such as small-group discussions and whole-class discussions, can be used in conjunction with surveys to collect information.  
    Survey Example: Statistics. The study of statistics is an excellent time to develop surveys and collect assessment information. Elementary school students commonly study the measures of central tendency (mean, median, mode) and the range for numerical data. Studying topics by developing their own surveys is a good way for children to practice the application of statistical concepts and skills. Children can find relevant topics by surveying each other, their families, their friends outside of school, other schoolmates, etc. They can gather information about such things as preferences in food, movies, television shows, pets and colors. The children can decide how to collect, organize, analyze, report, display (via circle graphs, bar graphs, pictographs, etc.), and interpret the information.

**INTERVIEWS**  
    Educators can assess children's cognitive and affective development through interviews (Liedtke, 1988). Interviews can be designed to meet the needs of the individual student through a variety of strategies:  
    \* Illustration: Children model mathematical concepts and skills and communicate them mathematically  
    \* Redirection: Children answer probing questions that guide them toward more complex ideas  
    \* Particularization: Children use examples to explain algorithms and procedures  
    \* Generalization: Children apply knowledge.  
    Interview Example: Place Value. Interviews are a good tool for assessing children's understanding of place value. Provide children with manipulatives such as place value blocks and a place value mat. The interview can be designed to consider each phase as described above:  
    \* Illustration: Ask children to model several number names for a given number (e.g., 134 ones is 13 tens and four ones, or it can be named as one hundred, three tens and four ones)  
    \* Redirection: Ask children to model 106, then guide children's understanding of the role of zero in the numeral 106  
    \* Particularization: Ask children to model and explain the processes for adding 36 and 75  
    \* Generalization: Give the children a real-world, non-routine word problem for which they can apply the concepts of place value through modeling and explaining the processes they perform.  
    Probing questions during interviews may guide children toward further learning and help them attend to misunderstandings. When appropriate, and to save time, conduct interviews with small focus groups of children. It is a good idea to have several questions prepared for individuals, as well as for the group.  
    Interviews also provide an opportunity to assess children's communication skills related to their use of mathematics as a language. In addition, interviews provide children with opportunities to ask questions that they may not otherwise ask in a large-group setting.

**CONCLUSION**  
    Implementing alternative assessment techniques is only valuable when we use the assessment information to improve children's learning. This implies that we use the assessment information to change curriculum and instruction, so that what we teach and how we teach enhances what and how children learn. The use of portfolios, journals, observations, self-assessment, communication, surveys and interviews to collect assessment information should lead to an examination of the content we present to children. Is the content developmentally appropriate? Is the content meaningful? Does the content reflect important concepts? We should also question instructional methodology. Does instruction provide for active learning? Are all the children given opportunities to learn in meaningful ways? Does instruction accommodate children's diverse needs? We can use the authentic assessment information we collect to provide authentic curriculum and instruction.  
    As we seek to employ such techniques to aid us in the improvement of mathematics teaching and learning, we should not ignore traditional techniques. Frechtling (1991) suggests that before accepting new assessment methods and rejecting old ones, we should look for the best parts of each. Only then will we be able to develop and implement assessment techniques, alternative or otherwise, that will support children's mathematics learning.  
      
   ~ Thomasenia L. Adams is Assistant Professor, Department of Instruction and Curriculum, University of Florida, Gainesville.

**REFERENCES**  
    Doud, D. (1989). The role of self-assessment in student grading. Assessment and Evaluation in Higher Education, 14(1), 20-30.  
    Frechtling, J. A. (1991). Performance assessment: Moonstruck or the real thing? Educational Measurement: Issues and Practices, 10, 22-25.  
    Hiebert, J., & Carpenter, T. P. (1992). Learning and teaching with understanding. In D. A. Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp. 65-100). New York: Macmillan.  
    Liedtke, W. (1988). Diagnosis in mathematics: The advantages of an interview. Arithmetic Teacher, 36(3), 26-29.  
    National Council of Teachers of Mathematics. (1989). Curriculum and evaluation standards for school mathematics. Reston, VA: Author.  
    Pidgeon, S. (1992). Assessment at key stage 1: Teacher assessment through record-keeping. In A. V. Kelly & G. M. Blenkin (Eds.), Assessment in early childhood education (pp. 122-143). London: Paul Chapman.  
    Thompson, A. G., & Briars, D. J. (1989). Assessing students' learning to inform teaching: The message in NCTM's Evaluation Standards. Arithmetic Teacher, 37(4), 22-26.  
    Webb, N. L. (1992). Assessment of students' knowledge of mathematics: Steps toward a theory. In D. A. Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp. 661-683). New York: Macmillan.  
    Wilson, L. D. (1993). What gets graded is what gets valued. National Center for Research in Mathematical Sciences Education Review, 2(3), 4-8.

WBN:

**Source:**Childhood Education, Summer 1998, Vol. 74 Issue 4, p220, 5p  
**Item:**507656541